REMARKS

Claims 1, 6, 7, 12, 16, 18, 20, 22, 27, 28, 33, 37, 40 and 42 are amended. Claims 13 and 34 are cancelled. Claims 44 and 45 are added. Claims 1-12, 14-33 and 35-45 are in the application for consideration.

The specification is amended to correct a typographical error, to be consistent with previous language in the same paragraph.

Independent claim 1 stands rejected as being unpatentable over Wolf in view of Ding et al. Claim 1 is amended to recite that the etching of at least a portion of the silicon nitride comprising layer is conducted using an etching chemistry consisting essentially of reactive components of ammonia and at least one fluorocarbon. The relied-upon section of Wolf does not in any way teach or suggest etching a silicon nitride layer using ammonia. On the other hand, Ding et al. everywhere teaches an etching method employing a process gas comprising fluorocarbon gas, an NH_3 generating gas, and a carbon-oxygen gas (i.e., see the Abstract). Ding et al. does not teach or suggest etching at least a portion of the silicon nitride comprising layer using an etching chemistry consisting essentially of reactive components of ammonia and at least one fluorocarbon. Rather, Ding et al. requires an etching gas utilizing fluorohydrocarbon, ammonia and a carbon-oxygen gas. Accordingly, Ding et al. necessarily requires a carbon-oxygen gas as part of its process. Thus, Ding et al. fails to disclose or suggest an etching composition in a silicon

nitride etch consisting essentially of reactive components of ammonia and at last one fluorocarbon.

The Examiner is reminded that the prior art must be considered in its entirety, including disclosures that teach away from the claims. MPEP §2141.02. Further, any proposed modification to an Applicant's claims cannot render the prior art unsatisfactory for its intended purpose. MPEP §2143.01. Clearly in its entirety, Ding et al. teaches away from an etching chemistry consisting essentially of reactive components of ammonia and at least one fluorocarbon, as Applicant recites in claim 1. Further, any assertion or suggestion by the Examiner of modifying Ding et al. in accordance with Applicant's claim 1 would inherently render such prior art unsatisfactory for its disclosed/intended purpose.

For the foregoing reasons, amended claim 1 is believed to be allowable, and action to that end is requested.

Those claims depending from claim 1 should be allowed as depending from an allowable base claim, and for their own recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Dependent claim 6 is rewritten in independent form. Such recites that the etching chemistry comprises a volumetric ratio of all fluorocarbon to ammonia of no less than 9:1. The relied-upon section of Wolf in no way discloses or suggests a combination of fluorocarbon and ammonia in etching

a silicon nitride layer. On the other hand, Ding et al. teaches away from a volumetric ratio of all fluorocarbon to ammonia of at least 9:1. Specifically at col.7, lns.8-13, Ding et al. clearly teaches a ratio of from 1:0 to about 2:1, and specifically teaches against using a ratio in excess of 2.5:1. This is also inherent from Fig. 3 of Ding et al., and at least with respect to ratios lower than 7:1. Accordingly, Ding et al. specifically teaches away from that which Applicant recites in claim 6. Consequently, the reference teaches away from the claims in accordance with MPEP §2141.03, and any allegation of modifying the reference to fall within the scope of Applicant's claim would render the prior art unsatisfactory for its intended purposes. MPEP §2143.01. Therefore, independent claim 6 as presented is not obvious and should be allowed. Action to that end is requested.

Claim 7 is amended to depend from claim 6 and recites an even larger volumetric ratio of all fluorocarbon to ammonia of being at least 20:1. Such is even further directed away from the teachings of Ding et al. as argued above. Therefore, dependent claim 7 should summarily be allowed, and action to that end is requested.

Independent claim 12 is rewritten in independent form and otherwise amended to be restricted to the fluorocarbon being selected from the group consisting of C_4F_6 and C_5F_8. None of Wolf, Ding et al. or Sugishima et al. is anywhere seen to disclose utilizing such fluorocarbons in the context of the

amended independ nt claim 12 combination. Accordingly, allowance of the same is urged.

Independent claim 16 is amended in the same manner in which claim 1 is amended. Accordingly, claim 16 should be allowed for the same reasons argued above with respect to the allowability of claim 1, as well as for its additional recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Those claims depending from claim 16 should be allowed as depending from an allowable base claim, and for their own recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Claim 18 is rewritten in independent form. It should be allowed for the same reasons argued above with respect to the allowability of claim 6, as well as for its additional recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Claim 20 is rewritten in independent form and otherwise amended as indicated above with respect to claim 12. Accordingly, independent claim 20 should be allowed for the same reasons argued above with respect to the allowability of claim 12, as well as for its own recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Independent claim 22 is amended in the manner described above with respect to claim 1. Accordingly, independent claim 22 should be allowed for the same reasons argued above with respect to the allowability of claim 1, as well as for its own recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Claim 27 is rewritten in independent form. Such should be allowed for the same reasons argued above with respect to the allowability of claim 6, as well as for its own recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Claims 28 is amended to depend from claim 27. Such should be allowed for the same reasons argued above with respect to the allowability of claim 7, as well for its additional recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Claim 33 is rewritten in independent form and otherwise amended in the manner identified above with respect to independent claim 12. Accordingly, independent claim 33 should be allowed for the same reasons argued above with respect to the allowability of claim 12, as well as for its own recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Claim 37 is amended in the same manner as described above with respect to claim 1. Accordingly, independent claim 37 should be allowed for the same reasons argu d above with respect to the allowability of claim 1,

as well as for its additional features which are neith r shown nor suggested in the cited art. Action to that end is requested.

Those claims depending from claim 37 should be allowed as depending from an allowable base claim, and for their own recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Claim 40 is rewritten in independent form. Such should be allowed for the same reasons argued above with respect to the allowability of claim 6, as well as for its additional recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Claim 42 is rewritten in independent form and otherwise amended in the manner described above with respect to the amendments to claim 12. Accordingly, independent claim 42 should be allowed for the same reasons argued above with respect to the allowability of claim 12, as well as for its additional recited features which are neither shown nor suggested in the cited art. Action to that end is requested.

Dependent claims 44 and 45 are added. Such should be allowed for the same reasons argued above with respect to the allowability of claim 7. Action to that end is requested.

This application is believed to be in immediate condition for allowance, and action to that end is requested.

Respectfully submitted,

Dated: 4/25/02

By: _____
Mark S. Matkin
Reg. No. 32,268

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application Serial No. 09/920,978
Filing Date . . . . . August 1, 2001
Inventor . . . . . Shane J. Trapp
Assignee . . . . . Micron Technology, Inc.
Group Art Unit 2813
Examiner . . . . . David S. Blum
Attorney's Docket No. MI22-1674
Title: Method of Forming Integrated Circuitry and Method of Forming Shallow Trench Isolation in a Semiconductor Substrate

VERSION WITH MARKINGS TO SHOW CHANGES MADE ACCOMPANYING RESPONSE TO MARCH 1, 2002 OFFICE ACTION

In the Specification

The replacement specification paragraphs incorporate the following amendments. Underlines indicate insertions and ~~strikeouts~~ indicate deletions.

The paragraph beginning at line 5 on page 2 has been amended as follows:

Another concern is selectivity in the etch relative to the typical overlying photoresist masking layer used to form the pattern in underlying layers. For example, certain etching chemistries utilized to etch underlying layers can provide less than desired selectivity to the photoresist layer itself. In some instances, the removal rate of the photoresist can be so great as to require undesired thicker layers of photoresist to assure that the mask pattern formed in the photoresist remains for the complete etch of the underlying layer(s). In other instances, reduced or less than desired selectivity in using certain etching chemistries can cause a reduction in the anisotropy of the etch or otherwise rounding and widening of the pattern openings themselves. This can result in less than a desired accurate transfer of the mask pattern to the underlying ~~layers~~ layer(s). Accordingly, there is a continuing effort to improve etching chemistries that increase selectivity to photoresist in the etching of underlying layers, particularly where the underlying layers include silicon nitride.

In th Claims

The claims have been amended as follows. Underlines indicate insertions and ~~strikeouts~~ indicate deletions.

1. (Amended) A method of forming integrated circuitry comprising:

forming a silicon nitride comprising layer over a semiconductor substrate; and

etching at least a portion of the silicon nitride comprising layer using an etching chemistry ~~comprising~~ consisting essentially of reactive components of ammonia and at least one fluorocarbon.

6. (Amended) ~~The method of claim 1 wherein~~ A method of forming integrated circuitry comprising:

forming a silicon nitride comprising layer over a semiconductor substrate; and

etching at least a portion of the silicon nitride comprising layer using an etching chemistry comprising ammonia and at least one fluorocarbon, the etching chemistry ~~comprises~~ comprising a volumetric ratio of all fluorocarbon to the ammonia of no less than 9:1.

7. (Amended) The method of claim ~~4~~ 6 wherein the etching chemistry comprises a volumetric ratio of all fluorocarbon to the ammonia of at least 20:1.

12. (Amended) ~~The method of claim 12~~ A method of forming integrated circuitry comprising:

forming a silicon nitride comprising layer over a semiconductor substrate; and

etching at least a portion of the silicon nitride comprising layer using an etching chemistry comprising ammonia and at least one fluorocarbon, wherein the fluorocarbon is at least one member selected from the group consisting of ~~C_4F_8,~~ C_4F_6, and C_5F_8, ~~CF_4, C_2F_6, C_3F_8, CHF_3, and CH_2F_2~~.

Cancel claim 13.

16. (Amended) A method of forming integrated circuitry comprising:

forming a layer comprising silicon nitride over a semiconductor substrate;

forming a patterned photoresist comprising masking layer over the silicon nitride layer, the patterned masking layer comprising mask openings therethrough; and

plasma etching the silicon nitride comprising layer through the mask openings substantially selectively to the photoresist comprising layer using an etching chemistry ~~comprising~~ consisting essentially of reactive components of ammonia and at least one fluorocarbon under etching conditions effective to substantially anisotropically etch the silicon nitride comprising layer, the etching chemistry comprising a volumetric ratio of all fluorocarbon to the ammonia of from 40:1 to 3:1 and providing increased selectivity to the photoresist comprising masking layer than would otherwise occur using identical etching chemistry and identical etching conditions without any ammonia.

18. (Amended) ~~The method of claim 16 wherein~~ A method of forming integrated circuitry comprising:

forming a layer comprising silicon nitride over a semiconductor substrate;

forming a patterned photoresist comprising masking layer over the silicon nitride layer, the patterned masking layer comprising mask openings therethrough; and

plasma etching the silicon nitride comprising layer through the mask openings substantially selectively to the photoresist comprising layer using an etching chemistry comprising ammonia and at least one fluorocarbon under etching conditions effective to substantially anisotropically etch the silicon nitride comprising layer, the etching chemistry comprising a volumetric ratio of all fluorocarbon to the ammonia of from 40:1 to 3:1 and providing increased selectivity to the photoresist comprising masking layer than would otherwise occur using identical etching chemistry and identical etching conditions without any ammonia, the etching chemistry ~~comprises~~ comprising a volumetric ratio of all fluorocarbon to the ammonia of no less than 9:1.

20. (Amended) ~~The method of claim 16~~ A method of forming integrated circuitry comprising:

forming a layer comprising silicon nitride over a semiconductor substrate;

forming a patterned photoresist comprising masking layer over the silicon nitride layer, the patterned masking layer comprising mask openings therethrough; and

plasma etching the silicon nitride comprising layer through the mask openings substantially selectively to the photoresist comprising layer using an etching chemistry comprising ammonia and at least one fluorocarbon under etching conditions effective to substantially anisotropically etch the silicon nitride comprising layer, the etching chemistry comprising a volumetric ratio of all fluorocarbon to the ammonia of from 40:1 to 3:1 and providing increased selectivity to the photoresist comprising masking layer than would otherwise occur using identical etching chemistry and identical etching conditions without any ammonia, wherein the fluorocarbon is at least one member selected from the group consisting of ~~C_4F_8~~, C_4F_6, and C_5F_8, ~~CF_4, C_2F_6, C_3F_8, CHF_3, and CH_2F_2~~.

22. (Amended) A method of forming shallow trench isolation in a semiconductor substrate, comprising:

depositing a silicon nitride comprising layer over a bulk semiconductor substrate;

depositing a photoresist comprising masking layer over the silicon nitride comprising layer;

patterning the photoresist comprising masking layer effective to form a plurality of shallow trench mask openings therethrough; and

etching the silicon nitride comprising layer through the mask openings substantially selectively relative to the photoresist using an etching chemistry ~~comprising~~ consisting essentially of reactive components of ammonia and at least one fluorocarbon.

27. (Amended) ~~The method of claim 22 wherein~~ A method of forming shallow trench isolation in a semiconductor substrat , comprising:

depositing a silicon nitride comprising layer over a bulk semiconductor substrate;

depositing a photoresist comprising masking layer over the silicon nitride comprising layer;

patterning the photoresist comprising masking layer effective to form a plurality of shallow trench mask openings therethrough; and

etching the silicon nitride comprising layer through the mask openings substantially selectively relative to the photoresist using an etching chemistry comprising ammonia and at least one fluorocarbon, the etching chemistry ~~comprises~~ comprising a volumetric ratio of all fluorocarbon to the ammonia of no less than 9:1.

28. (Amended) The method of claim ~~22~~ 27 wherein the etching chemistry comprises a volumetric ratio of all fluorocarbon to the ammonia of at least 20:1.

33. (Amended) ~~The method of claim 22~~ A method of forming shallow trench isolation in a semiconductor substrate, comprising:

depositing a silicon nitride comprising layer over a bulk semiconductor substrate;

depositing a photoresist comprising masking layer over the silicon nitride comprising layer;

patterning the photoresist comprising masking layer effective to form a plurality of shallow trench mask openings therethrough; and

etching the silicon nitride comprising layer through the mask openings substantially selectively relative to the photoresist using an etching chemistry comprising ammonia and at least one fluorocarbon, wherein the fluorocarbon is at least one member selected from the group consisting of ~~C_4F_8~~, C_4F_6, and C_5F_8; ~~CF_4, C_2F_6, C_3F_8, CHF_3, and CH_2F_2~~.

Cancel claim 34.

37. (Amended) A method of forming shallow trench isolation in a semiconductor substrate, comprising:

depositing a silicon nitride comprising layer over a bulk semiconductor substrate;

depositing a photoresist comprising masking layer on the silicon nitride comprising layer;

patterning the photoresist comprising masking layer effective to form a plurality of shallow trench mask openings therethrough to the silicon nitride comprising layer; and

plasma etching the silicon nitride comprising layer through the mask openings substantially selectively to the photoresist comprising layer using an etching chemistry ~~comprising~~ consisting essentially of reactive components of ammonia and at least one fluorocarbon under etching conditions effective to substantially anisotropically etch the silicon nitride comprising layer, the etching chemistry comprising a volumetric ratio of all fluorocarbon to the ammonia of from 40:1 to 3:1.

40. (Amended) ~~The method of claim 37 wherein~~ A m thod of forming shallow trench isolation in a semiconductor substrate, comprising:

depositing a silicon nitride comprising layer over a bulk semiconductor substrate;

depositing a photoresist comprising masking layer on the silicon nitride comprising layer;

patterning the photoresist comprising masking layer effective to form a plurality of shallow trench mask openings therethrough to the silicon nitride comprising layer; and

plasma etching the silicon nitride comprising layer through the mask openings substantially selectively to the photoresist comprising layer using an etching chemistry comprising ammonia and at least one fluorocarbon under etching conditions effective to substantially anisotropically etch the silicon nitride comprising layer, the etching chemistry comprising a volumetric ratio of all fluorocarbon to the ammonia of from 40:1 to 3:1, the etching chemistry ~~comprises~~ comprising a volumetric ratio of all fluorocarbon to the ammonia of no less than 9:1.

42. (Amend d) ~~The method of claim 37~~ A method of forming shallow trench isolation in a semiconductor substrate, comprising:

depositing a silicon nitride comprising layer over a bulk semiconductor substrate;

depositing a photoresist comprising masking layer on the silicon nitride comprising layer;

patterning the photoresist comprising masking layer effective to form a plurality of shallow trench mask openings therethrough to the silicon nitride comprising layer; and

plasma etching the silicon nitride comprising layer through the mask openings substantially selectively to the photoresist comprising layer using an etching chemistry comprising ammonia and at least one fluorocarbon under etching conditions effective to substantially anisotropically etch the silicon nitride comprising layer, the etching chemistry comprising a volumetric ratio of all fluorocarbon to the ammonia of from 40:1 to 3:1, wherein the fluorocarbon is at least one member selected from the group consisting of ~~C_4F_8~~, C_4F_6, and C_5F_8, ~~CF_4, C_2F_6, C_3F_8, CHF_3, and CH_2F_2~~.

New claims 44 and 45 have been added.

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